# Eagle Creek Headwaters Yellowstone Cutthroat Trout Restoration Project

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## *Introduction*

The Yellowstone Cutthroat Trout *Oncorhynchus clarkii bouvieri* (YCT) is native to the Snake River upstream of Shoshone Falls, Idaho and the Yellowstone River upstream of the confluence of the Tongue River in Montana (Behnke 1992). Yellowstone Cutthroat Trout historically occupied about 17,807 miles of habitat in the western U.S. (Endicot et al. 2015). Human activities including irrigation, agriculture, logging, mining, over harvest, and introduction of nonnative fish species (Gresswell 1995, 2008; Thruow et al. 1988; Kruse et al. 1997; Allendorf and Leary 1988; May et al. 2007) have resulted in a significant decrease in the historic range of YCT. Within YCT historic range, they are considered a "sensitive species" or a "species of special concern" by all state and federal agencies, including the Wyoming Game and Fish Department, and Region 2 of the U.S. Forest Service (Figure 1; Johnson 1987, Gresswell 1995, Wyoming Game and Fish Department 2010).

Yellowstone Cutthroat Trout currently occupy approximately 7,592 miles (43%) of their historic habitats and 3,158 miles (27%) of occupied habitat contain genetically unaltered YCT (Endicot et al. 2015). Introduced Rainbow Trout *Oncorhynchus mykiss* hybridize with YCT, resulting in a loss of genetic integrity. Often, where these species coexist, hybridization occurs (Allendorf and Leary 1988). Hybridization is a leading cause of loss of YCT populations (Kruse and Hubert 2000). Gresswell (1995) and Kruse et al. (2000) considered non-native fish species the greatest threat to persistence of YCT. Some cutthroat subspecies evolved under the influence of interspecific interactions and have become effective at resource partitioning in the presence of competing species. Yellowstone Cutthroat Trout evolved in the presence of few other fish species, and developed as generalists faring poorly when competing species were introduced (Griffith 1988). In Yellowstone National Park the introduction of brook trout *Salvelinus fontinalis* (BKT) has nearly always resulted in the disappearance of YCT (Varley 1981; Varley and Gresswell 1988).

YCT historically occupied approximately 183 miles of the North Fork Shoshone River drainage, and while YCT do still persist in the drainage, they exist with rainbow trout in a hybrid swarm and are of little conservation value. Only one conservation population of YCT persists in the North Fork Shoshone River drainage in a small lake (8.8 ac) and inlet stream (>0.5 mi) in the Bear Creek drainage.

In 1998, YCT were petitioned for listing as a threatened species under the Endangered Species Act (Biodiversity Legal Foundation et al. 1998). The petition was rejected in February 2001 (U.S. Fish and Wildlife Service 2001), but in December 2004, U.S. District Court for the District of Colorado ruled, that the U.S. Fish and Wildlife Service (FWS) illegally rejected the petition. The FWS conducted a 12-month status review of the species and found listing unwarranted (U.S. Fish and Wildlife Service 2006). The proponents filed a notice of intent to sue which is still pending.

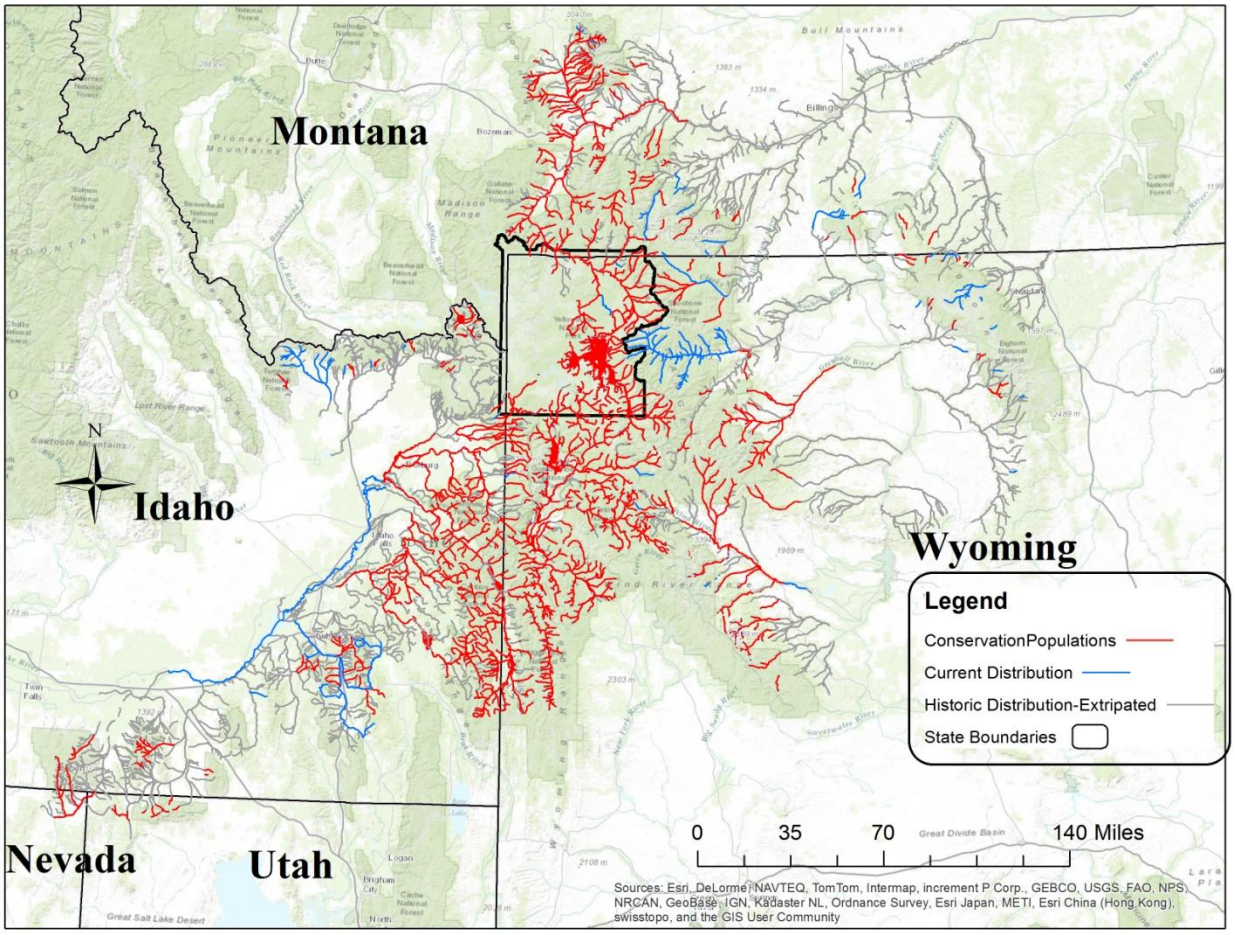


Figure 1. Historic and current range of Yellowstone Cutthroat Trout.

## *YCT Management Direction*

This proposed project follows the direction of several WGFD guiding documents. Wyoming's State Wildlife Action Plan (SWAP; WGFD 2010) is a comprehensive strategy to maintain the health and diversity of wildlife within the state, including reducing the need for future listings under the Endangered Species Act. The SWAP lists Yellowstone Cutthroat Trout as a Native sensitive species level 2, meaning the species is restricted in numbers and distribution, but extirpation is not imminent. A Conservation Action listed in the SWAP is the removal of competing or hybridizing nonnative species to secure, enhance and restore YCT populations. A Plan for the Conservation and Management of Yellowstone Cutthroat trout in Wyoming (Burckhardt et al. in prep) identifies the Eagle Creek headwaters as a priority drainage for Yellowstone cutthroat restoration activities.

Further, this project is congruent with several multi-jurisdictional agreements regarding the conservation and management of YCT to which WGFD are signatories. The WGFD are signatures to the memorandum of agreement for conservation and management of Yellowstone Cutthroat Trout (*Oncorhynchus clarkii bouvieri*) among Montana, Idaho, Wyoming, Nevada,

Utah, U.S Forest Service, Yellowstone National Park, and Grand Teton National Park (May 2000). This document acknowledges the following relevant goals and objectives:

> Goal: Ensure the persistence of the Yellowstone Cutthroat Trout subspecies within its historic range. Manage YCT to preserve genetic integrity and provide adequate numbers and populations to provide for protection and maintenance of intrinsic and recreational values associated with this fish.
>
> Objective 2. Restore populations. Increase the number of stream populations by restoring YCT within their native range. Local restoration goals and approaches would be developed to meet this objective.

The Conservation Strategy for Yellowstone Cutthroat Trout (*Oncorhynchus clarkii bouvieri*) in the States of Idaho, Montana, Nevada Utah and Wyoming (Range-Wide YCT Conservation Team, 2009) identified the introduction and subsequent spread of nonnative trout and the resulting adverse effects as a major long-term threat to YCT. Objective 3 of this Conservation Strategy includes: Increasing the number of populations by restoring YCT within their broad historical range. Local restoration goals and approaches will be developed to meet this objective, but the typical approaches will likely include: creating barriers, eliminating non-native fish species, increasing connectivity, and reintroducing native fish.

This proposed project is located within the Washakie Wilderness of the Shoshone National Forest. This project follows guidelines for fish and wildlife management in U.S. Forest Service administered wilderness areas (Association of Wildlife and Fish Agencies 2006). Forest Service policy (FSM 2320) states that: chemical treatment may be necessary to prepare waters for the reestablishment of indigenous fish species, consistent with approved wilderness management plans, to conserve or recover federally listed threatened or endangered species, or to correct undesirable conditions resulting from human activity. Proposals for chemical treatments would be considered and may be authorized by the Federal administering agency through application of the MRDG as outlined in Section E., General Policy (Association of Wildlife and Fish Agencies 2006). Any use of chemical treatments in wilderness requires prior approval by the Federal administering agency.

The Shoshone National Forest Plan (Shoshone National Forest, 2014) lists a goal that Yellowstone Cutthroat Trout occupy more suitable stream habitat than was occupied when the Plan was approved, with an objective that The Yellowstone Cutthroat Trout population has expanded to at least four suitable stream reaches within priority watersheds. The Eagle Creek watershed was identified as one of those priority watersheds.

## *Purpose & Need for Action*

The purpose of the proposed action is to facilitate the restoration of a native YCT metapopulation within the North Fork Shoshone River drainage in Eagle Creek headwaters. The need for the project is to expand the distribution and abundance of native YCT within the North Fork Shoshone River drainage by eradicating the existing non-native Brook Trout population above a natural barrier falls. Additionally, expansion of the YCT distribution in the Eagle Creek

drainage will benefit native YCT recovery efforts with the species historic range. The project will also help conserve the species and reduce the likelihood of becoming listed under the Endangered Species Act (ESA).

## *Project Location*

The location of this proposed project is approximately 45 miles west of Cody, WY (Figure 2; T51N R109W Sections 7-36). The treatment area will include the entire Eagle Creek watershed upstream from a barrier falls just below the Cabin Creek confluence at an elevation of 7,075 ft (Figure 3; UTM ,582636 E 4917469 M N Z12  NAD83).

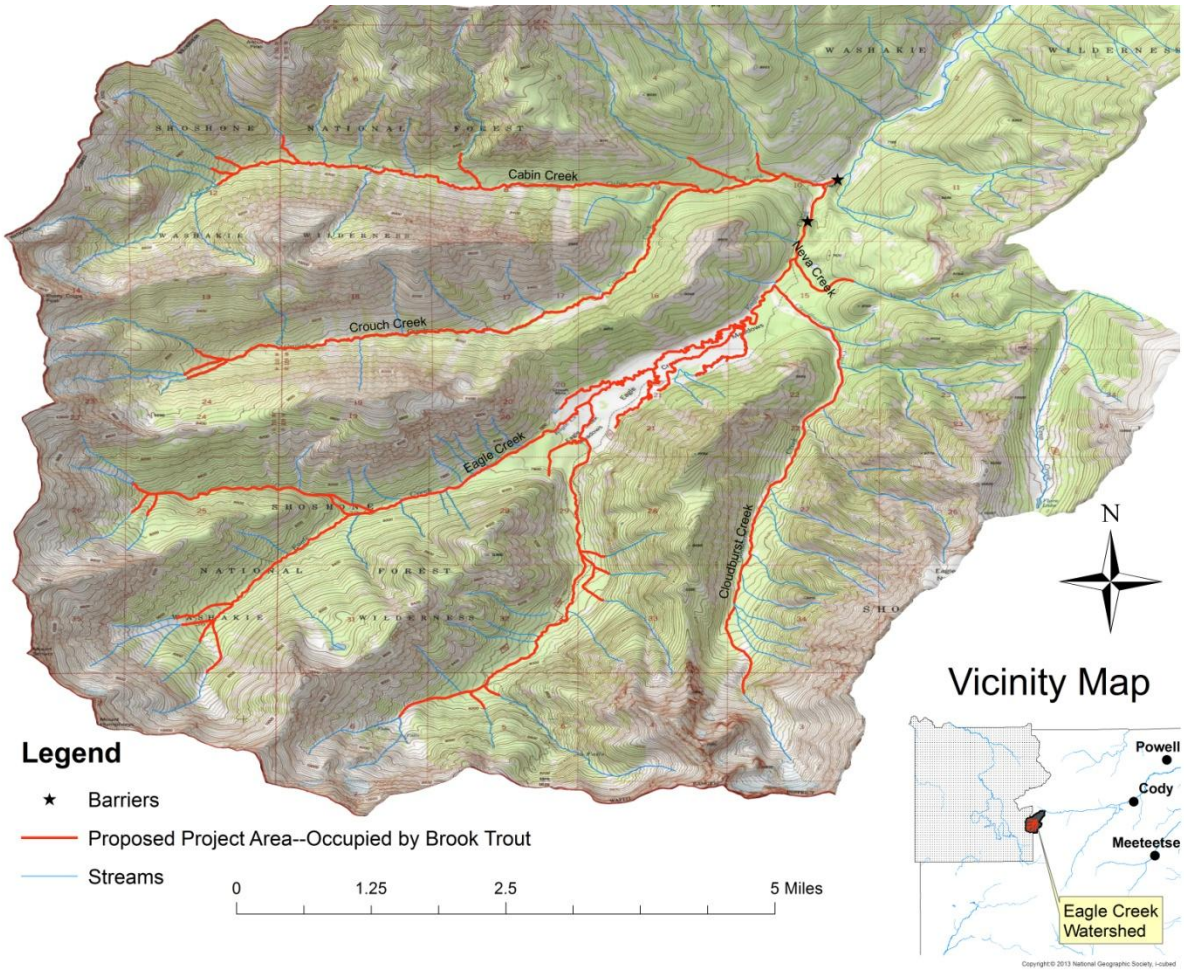


Figure 2.  Eagle Creek drainage treatment area including areas currently occupied by nonnative Brook Trout and barriers present within the treatment area.

The entire project basin lies within the Washakie Wilderness of the Shoshone National Forest. This is an extremely remote location accessible by foot or horseback only. Eagle Creek Meadows, the likely base for this proposed operation, is approximately 10 miles from the trailhead. Few streams within the project area are accessible by trail. Named streams involved in the project include Eagle Creek, Cabin Creek, Crouch Creek, Cloudburst Creek, and Neva Creek. Nonnative trout removal will be necessary from all streams where they are present (Figure 2). The project basin has approximately 30 stream miles currently occupied by fish.

Figure 3. Waterfall barrier on Eagle Creek below the confluence of Cabin Creek at the downstream end of the proposed project area.

Streams in the project basin originate high in the Absaroka Mountains at elevations exceeding 11,000ft. Water in the basin flows northeasterly passing over the falls at the downstream end of the proposed treatment area at an elevation of 7,075 (UTM ,582636 E 4917469 M N Z12 NAD83). Streams within the basin range from high to moderate gradient A, B and C channel types in the headwater tributaries to moderate gradient C and E channel types in Eagle Creek Meadows. Riparian vegetation consists of dense willow and conifers. Recent beaver activity is present in some portions of Eagle Creek Meadows. Particular attention will have to be paid in the vicinity of Eagle Creek Meadows. This area has substantial groundwater inputs, numerous small channels, off channel ponds, and beaver pond complexes that will have to be treated with substantial amounts of sand-mix rotenone and treated as standing water treatments.

Several waterfalls or high-gradient reaches are present within the watershed. These areas serve as barriers to upstream movement of trout and allow precise delineation of the upstream distribution of fish. A small waterfall (approximately 3 ft tall) on Eagle Creek between the confluences of Neva Creek and Cabin Creek (UTM 582309E 4916841 M N Zone12, NAD83)

may serve as an intermediate barrier allowing for treatment of the project area to be broken into two units. However, because this waterfall is likely not a complete barrier to upstream fish movement, treatment of these two units should occur concurrently at least one year.

***Existing Fishery***

Brook trout are the only fish present above the falls on Eagle Creek. Yellowstone Cutthroat Trout were native to Eagle Creek below the falls, but it is unknown if they were ever present above the falls, as no documented fish surveys were conducted in the drainage prior to stocking. Brook trout are currently present in approximately 30 miles of stream above the falls. Brook Trout originated from stocking which began as early as 1913 (D.C. Booth Historic National Fish Hatchery Records, unpublished data) and BKT were established in 1958 when the first fish surveys were conducted. No stocking records have been found for the proposed treatment area. The earliest fisheries information includes creel reports dating back to 1958 in which brook trout were captured. Kruse (1997) surveyed multiple locations within the proposed treatment area, finding only brook trout. Subsequent sampling throughout the drainage has found only brook trout. Sampling was conducted in Eagle Creek Meadows in 2013 to determine the current status of the fishery. A two-pass depletion population estimate was conducted on a 420 ft reach of Eagle Creek with two backpack shockers and three netters in Eagle Creek Meadows to determine the biomass and size structure of the BKT population (Table 1, Figure 4).

Table 1. Mean lengths with ranges, mean weight with ranges, population and biomass estimates, and mean relative weights for brook trout greater than six in captured with BP in Eagle Creek, August 27, 2013.

| Species | Size Group | No. | Mean Length | Length Range | Mean Weight | Weight Range | No./Mile | (cv %) | Lb/Mile | (cv %) | Mean W*r* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| BKT | ≥1 | 94 | 5.6 | 2.2-11.4 | 0.14 | 0.02-0.57 | 1,643 | (3.58) | 115.4 | (7.52) | 101 |
| BKT | ≥6 | 33 | 7.7 | 6.1-11.4 | 0.19 | 0.08-0.57 | 429 | 4.46 | 83.1 | (6.51) | 90 |

Our sampling indicates there is a robust population of small brook trout in Eagle Creek Meadows. Less than 30 percent of the fish sampled were greater than 6 inches in length and only 13 percent were greater than 8 inches in length (Figure 4).

Angling pressure within the project area is largely unknown but is believed to be low to moderate within Eagle Creek Meadows during the summer months and likely low to non-existent in the peripheral tributaries. There are several outfitters and private individuals that take pack trips into Eagle Creek Meadows, and many utilize the brook trout fishery.

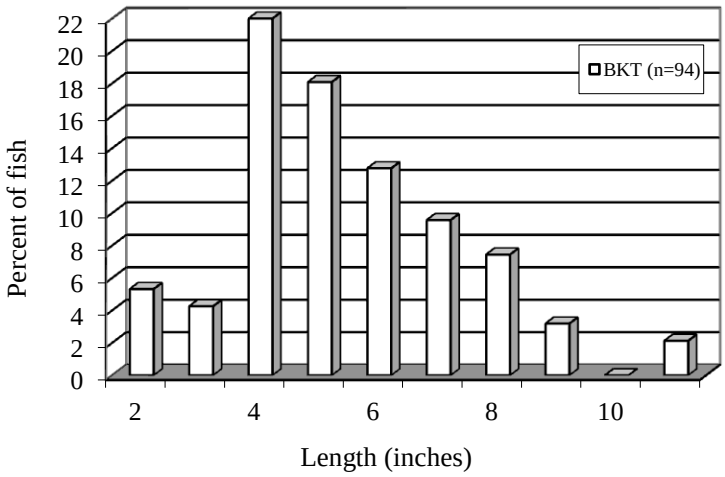


Figure 4. Length frequency distribution of BKT sampled in Eagle Creek August 28, 2013.

## *Proposed Action*

We propose to apply the chemical rotenone to the Eagle Creek and tributaries above a barrier falls to remove the existing fishery and restock with native Yellowstone Cutthroat Trout to establish a conservation population of this fish in the North Fork Shoshone River drainage. The only option currently available for establishing a conservation population of YCT in Eagle Creek will require the chemical removal of all nonnative trout. The drainage will then be restocked with genetically pure Yellowstone Cutthroat Trout. The geography of the drainage area above the falls provides the opportunity to create a relatively large refuge for YCT with the falls as a barrier to nonnative trout that occupy downstream habitats.

## *Issues*

Issues are points of discussion, debate, or disagreement regarding anticipated effects of the proposed action. The most contentious component of this project will be the application of the piscicide rotenone to remove the existing fishery. Rotenone is the only chemical available and approved by the Environmental Protection Agency (EPA) for this use (EPA 2007). It is the potential effects of this proposed action that provide focus for the analysis completed, influence alternative development in the analysis, and lead to project design criteria.

***Piscicide application***

Chemical treatment of the Eagle Creek drainage will introduce the piscicide rotenone into the water resulting in fish-killing concentrations. Rotenone is approved for fish removal projects and is highly effective at killing fish at low concentrations. Rotenone is derived from the derris root, a plant native to tropical areas of Central and South America. Native peoples dried the root and crushed it into a powder, which they applied to water to catch and kill fish for food. In the

liquid formulation, the rotenone is extracted from the derris root and added to emulsifiers to create a formulation that has a concentration of 5% rotenone. Rotenone has been extensively used to manage fish populations and has been routinely used in stream and lake rehabilitation. Rotenone kills fish by blocking a specific metabolic pathway at the cellular level. It enters the blood stream of fish through their gills. Rotenone is not readily absorbed into the blood through the digestive system or through the skin, lessening the risk of exposure to non-target organisms that may consume treated waters or fish killed by rotenone (Finlayson et al. 2000).

Rotenone has a half-life of 14 hours at 24C, and 84 hours at 0C, meaning that half of the rotenone is broken down and is no longer toxic within that amount of time. As temperature and sunlight increase, the rate that rotenone is broken down also increases. Higher alkalinity (>170 ppm) and pH (>9.0) also increase the rate of breakdown. Rotenone tends to bind to and react with organic molecules rendering it ineffective, so higher concentrations are required in streams with large amounts of organic debris. This binding effect is also thought to reduce the probability of rotenone affecting groundwater supplies. Without detoxifying, rotenone in the streams will be reduced to non-toxic levels within 24 hours due to its natural breakdown and dilution in the aquatic environment. Given the low concentration of chemical to be used, the short duration of the project, and the rapid natural breakdown of the piscicides, water quality impacts should be temporary and minimal. To reduce the potential impact to water quality and non-target organisms various Project Design Features will be employed.

***Impacts of piscicides on water quality***

The Wyoming Department of Environmental Quality (WY DEQ) designation for all waters in the project area is Class 1 (WY DEQ 2001, 2007). The Notice of Intent to discharge will be filed with the Wyoming Department of Environmental Quality for permitting purposes. While there will be changes in water quality during chemical application the effects will be short-term, localized, and not adversely impact long-term water quality. The application of rotenone to the Eagle Creek drainage will result in a very short term reduction in water quality that is expected to last approximately one day as the piscicide naturally breaks down and flows out of the treatment area.

In addition, EPA has considered the effects of the use of rotenone on the environment, and stated that when it is applied directly to waters of the United States according to its "intended purpose," it is not a pollutant under the Clean Water Act and thus not subject to the Act's permit requirements (USDI 2007). Project design features will also aid in protecting water quality. There will be no filling or obstruction of floodplains or wetlands during the proposed treatments. Rotenone does not affect aquatic or riparian vegetation.

The mobility of rotenone in soil is low. In fact, the leaching distance of rotenone is only 2 cm in most types of soils. This is because rotenone is strongly bound to organic matter making it unlikely that it would enter ground water. At the same time, rotenone breaks down quickly into temporary residues that will not persist as pollutants of ground water. Ultimately rotenone breaks down into carbon dioxide and water.

The EPA approves rotenone for the use intended in this project and it will be applied according to label instructions by personnel certified as Commercial Pesticide Applicators by the Wyoming Department of Agriculture. Changes in water quality during the project will not impair other uses. Rotenone will not affect plants which will still be of suitable quality for use by livestock, other mammals and birds.

In summary, there will be short-term direct effects to water quality as a result of the chemical treatment with rotenone. The primary direct effect will be the toxicity of rotenone to aquatic organisms including fish and gill breathing invertebrates. Rotenone dissipates in flowing waters relatively rapidly (often less than 24 hours) due to dilution and increased rates of hydrolysis and photolysis (Finlayson et. al 2000).

***Impact of piscicides on Aquatic Life***

The application of rotenone in the Eagle Creek drainage has the potential to affect aquatic life including fish amphibians and aquatic invertebrates. Extensive sampling within the project area has detected only nonnative brook trout, the target of our removal. Successful treatment of this drainage will remove all nonnative brook trout.

The application of rotenone has the potential to also impact non-target aquatic organisms, namely aquatic invertebrates and juvenile amphibians such as tadpoles and larval salamanders, that respire through gills or skin.

Aquatic invertebrates will be temporarily reduced in numbers. The time needed for aquatic invertebrate communities to recover following rotenone treatment has varied from a few months to 3 or more years. Generally, aquatic invertebrate assemblage abundances return to pre-treatment levels more quickly than measures of biodiversity or community composition. Rapid recovery (< 1 year) to pre-treatment levels has been documented following some rotenone applications (Ling 2003, Hamilton et al., 2009). Assemblage abundances typically return to pre-treatment levels within a few months to a year (Binns 1967, Cook and Moore 1969, Beal and Anderson 1993, Mangum and Madrigal 1999, Melaas et al. 2001, Whelan 2002, Skorupski 2011). Mangum and Madrigal (1999) found that the total abundance of invertebrates returned to pre-treatment levels in 1 to 36 months across their sampling sites. Hamilton et al. (2009) reported declines in invertebrate abundance immediately following treatment; however, no significant differences in abundance were detected 1-year following sampling.

Areas upstream from the target waters or refugia left in the fishless portions of target waters will provide a source for rapid recolonization. The natural, downstream drift of aquatic insects generally results in the rapid recolonization of streams following their removal by natural or man-made events (Hynes 1972). Recolonization will also occur by aerial dispersion from nearby waters. Most or all of the invertebrate species will repopulate the treated area within one or two years (California Dept Fish and Game 1994). Whelan (2002) reviewed the effects of the 1995 and 1996 rotenone treatments on Manning Creek, Utah.

Whelan (2002) indicated that leaving fishless stream reaches untreated and using the minimum rotenone concentration and treatment time necessary to achieve the objectives of trout removal were reasonably effective mitigation measures to speed aquatic macroinvertebrate recovery. The majority of taxa were recovered and found in the post-treatment samples. Interestingly, many taxa were only found post-treatment. Finally, while a few individual taxa were not found post-treatment, Whelan (2002) noted “there were almost as many taxa found in 1988 and 1990 that were missing by 1995 [immediately] prior to the treatment, as there were taxa found in 1995 that were still missing in 1999 after the treatment”.

Whelan (2002) found that aquatic macroinvertebrate responses to natural events were often similar to rotenone treatments. Natural disturbances faced by macroinvertebrates in the project area include snowmelt runoff and flooding, drought, thunderstorm flood events, and wildfire. Floods can result in major movement of the streambed, greatly affecting

macroinvertebrate population levels by scouring and deposition. Rotenone treatments at low concentrations for short treatment times are likely less impacting to aquatic macroinvertebrates than major natural events. Whelan (2002) summarized mechanisms that aquatic macroinvertebrates have evolved to live in dynamic environments that make them potentially able to survive or persist through rotenone treatments. These include resistant egg stages, multiple overlapping generations, life stages that live deep in the in the gravel of the stream with upwelling groundwater, life stages that live in silt or aquatic vegetation that binds up rotenone, and dispersal by winged adults from refuge areas. Some taxa, especially those with low oxygen requirements, are relatively resistant to rotenone even as nymphs or adults.

A secondary indirect effect of the treatment will be a temporary increase in the nutrient input to the water as a result of decomposition of fish that are killed. This effect will occur for a period of less than one week. However, natural mortality has always occurred in the target waters and the increase will be insignificant with respect to the ecosystem. Some of the nutrients will likely be rapidly assimilated by rebounding aquatic macroinvertebrate populations.

Rotenone has been found to be toxic to leopard frog tadpoles (Fontenot et al. 1994, Hamilton 1941) at concentrations normally used in fish control. Various factors may affect the toxicity of rotenone to amphibians and reptiles, including temperature, pH, alkalinity, flow rate, turbidity, rotenone formulation and dosage (Fontenot et al. 1994). As leopard frogs use different habitats for breeding and wintering, applications during the late summer should minimize exposure to leopard frogs, particularly the larval stages. Bradbury (1986) noted that a fall application of rotenone may have fewer negative effects on leopard frogs, as by this time they have completely metamorphosed. While few studies examining the effects of rotenone on boreal toads have been conducted, effects are expected to be similar.

Observations in several Montana Fish, Wildlife, & Parks (MFWP) treatments in the Flathead River Basin indicate that amphibians persist after treatments. In an unpublished report MFWP biologists observed that Tom Tom Lake, located in the South Fork Flathead drainage, was treated with rotenone in October and a survey one year later found numerous spotted frog juveniles, tailed frogs, and long toed salamander larvae. Chandler and Marking (1982) found that leopard frog tadpoles were 3 to 10 times more tolerant to rotenone than fish. Brown and Ball (1943) reported that during a May rotenone treatment in Michigan, tadpoles were "greatly affected," but within three months were "extremely numerous."

Few amphibians are likely to be present in the project area due to low habitat quality through much of the project area. Columbia spotted frogs were the only amphibians observed during surveys in 2009, 2010, 2013 and 2014. Application of rotenone is not expected to kill all amphibians in the project area if they are present. Mortality will be limited to larval stages. Implementing these projects in the late summer will help reduce any potential impacts to larval stages if larvae have completely metamorphosed. The project may impact individuals, but is not likely to cause a trend to federal listing or a loss of viability for boreal toads, leopard frogs, and Columbian spotted frogs.

Potassium permanganate will be used to detoxify rotenone during treatments at some of the project waters. Potassium permanganate will degrade to nontoxic, common compounds within an hour of application at the concentrations that will be used. The detoxification is not immediate in space, but requires a short mixing zone where the potassium permanganate is in contact with and oxidizes the rotenone. Below this mixing zone both fish and aquatic macroinvertebrates will survive.

***Impacts to Health and Human Safety***

Rotenone is a restricted-use pesticide due to aquatic and acute inhalation toxicity. It can be irritating to eyes nose, mouth, or throat, is an eye irritant and may be fatal if inhaled or swallowed. Once diluted in a stream or lake at 1-5 ppm, rotenone becomes a negligible hazard to humans and other terrestrial animals. Rotenone will be applied according to label specifications directed by a certified WGFD piscicide applicator and technicians using appropriate safety gear and procedures.

Rotenone does not affect humans or other animals that consume treated waters or fish killed by rotenone for two reasons. First, the main pathway for rotenone to enter the bloodstream is through the respiratory system. The chemical is not readily absorbed into the blood through the digestive system or skin of humans. Second, the concentration needed to kill fish is extremely low (1-5 ppm) compared to the concentration necessary to affect humans or other terrestrial animals.

At the concentrations used to kill fish, it has been estimated that a 132-lb person would have to consume over 60,000 liters of treated water at one sitting to receive a lethal dose (Sousa et al, 1987). Using a safety factor of 1,000X and the most conservative safe intake level, a person could still drink 14 liters of treated water per day. In addition, extensive testing has not shown rotenone to be carcinogenic (Bradbury 1986).

Rotenone does not bioaccumulate in the tissues of animals. The livers of fish and terrestrial animals can readily metabolize non-lethal doses of rotenone, converting the chemical into inert compounds that are non-toxic and can be excreted through urine. The product label indicates that fish killed by rotenone should not be consumed by humans. This is because sufficient human clinical trials have not been conducted to certify that fish killed with rotenone are safe for human consumption. The safety guidelines on the product label, which include the use of chemical-resistant gloves, eye protection and the use of an organic vapor cartridge type respirator, will be followed by all personnel who handle or apply the chemical. Personnel who handle KMnO4 will follow similar safety precautions, including protective gloves, safety glasses and a respirator. Rotenone becomes a negligible hazard to humans once diluted in a stream or lake.

Even though rotenone has been shown to be safe to humans, as a matter of policy, the EPA does not set tolerances for pesticides in potable water. At the same time, the EPA has exempted rotenone from tolerance requirements when applied intentionally to raw agricultural commodities. The State of California (CDFG 1994) and the National Academy of Science (1983) have computed "safe" levels of rotenone in drinking water that are roughly equivalent to the detection level of rotenone in water (0.005 ppm pure rotenone). Municipal drinking water supplies have been treated with rotenone in at least seven states. In some cases, rotenone treatment has been used to protect or improve drinking water quality (Hoffman and Payette 1956; Barry 1967).

Drinking water supplies will not be affected by the use of potassium permanganate because it rapidly breaks down into potassium, manganese, and water. In addition, no target streams are used directly as water sources.

***Potential for chemical spill or accident***

With any project that requires the use of chemicals, there is always the risk of an accidental spill. Following the safe-handling information on the product label can mitigate the risk of a spill. In the event of a spill, the Wyoming Department of Environmental Quality, the US Forest Service and the Wyoming Department of Agriculture will be notified immediately. The risk of contaminating surface waters will be minimized by transporting and storing the chemical away from surface water. The properties of the chemical reduce the risk of a potential spill affecting groundwater. The ability of rotenone to move through soil is low to slight. Rotenone moves only 2 cm (<1 inch) in most types of soils. Rotenone is strongly bound to organic matter in soil, so it is unlikely that rotenone will enter groundwater (Dawson et al. 1991). The liquid formulation of rotenone is flammable because of the emulsifiers in the formulation. The safe handling of the chemical according the product label, which includes keeping the chemical from open flames or sparks, will minimize the risks of fire and explosion. Before the chemical is administered to the stream, it will be sufficiently diluted in water at the drip station, rendering the solution non flammable.

***Impacts to recreation and public use of area, local economy***

This project is located entirely on US Forest Service land that receives recreational use by the public including fishing, hunting, hiking, and wildlife viewing. The Eagle Creek drainage receives moderate to light recreational use in the vicinity of Eagle Creek Meadows and light to no recreational use in peripheral tributaries. This project will result in the temporary reduction of fishing opportunities in the Eagle Creek drainage immediately following the initial chemical treatment for a period of up to five years. The fishery is planned to be restored with YCT in the early summer after the second year of the treatment once complete removal of the target species has been confirmed. Angling will once again be allowed. The Eagle Creek drainage is within an area of abundant fisheries resources. Anglers displaced by the temporary removal of this fishery can readily find angling opportunities in nearby drainages.

Eagle Creek Meadows is the destination for commercial outfitters permitted to conduct pack trips in the Shoshone National Forest. Angling is an included activity for clients partaking in these trips. This proposed project has the potential to affect these commercial outfitters, displacing them to nearby drainages, or removing the angling component to their pack trips. Several outfitters have been notified in advance of this potential project.

***Impacts on the Washakie Wilderness Area***

The entire project area is within the Washakie Wilderness Area. Conducting this treatment has the potential to impact 'wilderness character' in the treatment area. Briefly, wilderness character can be compromised when wilderness ecological systems and processes are impacted by effects of modern civilization, including human control and manipulation. Removal of nonnative trout and restoring native YCT can be considered improving the wilderness character of this water through the restoration of a native fish species.

A Minimum Required Decision Guide (MRDG) process will be used to assist managers in minimizing the effects of actions within wilderness areas. Through this process we will determine the following key points: 1) the project is necessary to preserve an important quality of wilderness character (naturalness) by restoring native fish to the area, and 2) mechanized equipment will only be used if it is the determined to be the minimum tool necessary to complete

the project. There will be no permanent structures installed in the wilderness. These points are all consistent with law, regulation, and Forest Service policy.

Minor impacts to wilderness users could occur during the 1-2 weeks needed annually to prepare and implement the project. Minimal short-term impacts to stream segments in and adjacent to the wilderness area will occur under the proposed treatment. These impacts are limited primarily to temporary reductions in stream-dwelling aquatic invertebrates. There could also be temporary impacts to wilderness character from ground crews conducting treatment activities. Such impacts could temporarily reduce the wilderness characteristics of "opportunities for solitude or a primitive and unconfined type of recreation" in the short-term. YCT population restoration will improve wilderness characteristics in the long-term by contributing to the "preservation and use in an unimpaired condition," making "the imprint of man's work less noticeable and improving the ecological characteristics."

## *Public Outreach*

Prior to undertaking any action, a substantial effort is needed to contact potential affected parties and to disseminate information. Public outreach conducted to date includes an article included in the 2014 and 2015 Big Horn Basin Angler Newsletter. Numerous phone calls have been taken to describe the proposed project to interested or concerned anglers. The project has been discussed with several individuals that may be directly impacted including local outfitters that take clients into this area. Presentations regarding this project have been given to the East Yellowstone Chapter of Trout Unlimited, Shoshone Back Country Horsemen and as a part of the Buffalo Bill Center of the West lunchtime expedition. Articles about this project have been run in the Cody Enterprise, Billings Gazette, and Powell Tribune.

Additional public outreach will be conducted. A public meeting will be scheduled and public input will be collected at the meeting and through an on-line portal.

## *Rotenone Application Process*

A 5% formulation of rotenone (Prenfish Toxicant, Zoecon) will be applied to in the Eagle Creek Drainage according to label directions using a constant head drip station (Figure 5). All rotenone drip stations will be monitored to ensure continuous application of rotenone. Drip stations will be allowed to run for at least 4 hours. Drip stations will be spaced within 2 hours of stream flow. The exact distance will be determined following flow studies and a bioassay as needed prior to the chemical treatment. A bioassay is an experiment to determine the relative strength of a substance by comparing its effect on a test organism. A mix of Prentox Fish Toxicant Powder (Zoecon), gelatin, and clean sand (sand mix) and will be used to treat peripheral water and areas of poor water mixing to remove potential refugia from the chemical treatment. Teams of sand mix applicators will walk the length of the treatment area to ensure areas not receiving direct flow from drip stations receive a lethal dose of rotenone. Additionally Prenfish Toxicant will be loaded in backpack sprayers for treatment of standing waters.

Rotenone will be packed to the application sites using backpacks or on horseback and will be stored according to Shoshone National Forest food storage regulations.

The rotenone will be detoxified with potassium permanganate (KMnO4) at the bottom of the treatment area. The expected concentration of potassium permanganate needed to neutralize rotenone will be 2-4 mg/L (ppm). Potassium permanganate is the chemical most often used to quickly neutralize (oxidize) rotenone. Potassium permanganate is a purple crystalline solid that readily dissolves in water. It is a strong oxidizer that is commonly used in drinking water treatment and other treatment facilities to oxidize metals, kill bacteria and viruses, and remove unpleasant tastes (USEPA 1999).


Figure 5. A typical constant-head drip station, showing five gallon jug with diluted rotenone and constant head standpipe applying rotenone to the stream.

Potassium permanganate can be toxic to fish but is quickly broken down when it reacts to organic material and rotenone in stream water. Breakdown components of potassium permanganate (potassium, manganese, and water) are common in nature and have no deleterious environmental effects at concentrations used for neutralization of piscicides (Finlayson et al. 2000). At 2-4 ppm, the expected travel time of the permanganate is less than 1 mile before it is completely reduced. The reduction of permanganate can be visually determined by its changing from a purple to a rust color. This will allow for complete detoxification of the rotenone prior to the confluence with the North Fork Shoshone River. Bioassays will be conducted during the chemical treatment to determine the effectiveness of producing a 100% fish kill within the treatment area and ensure effective detoxification below the primarily detoxification station (Figure 6). The treatment bioassay will consist of placing caged fish and block nets at the downstream terminus of each treatment segment but before subsequent drip stations. This effectively separates the treatment into smaller treatment units. Fish will be collected from the Eagle Creek drainage during the first year of treatment and pure YCT from the WGFD brood source will be used in subsequent years to conduct these bioassays. The caged fish will serve to ensure that a lethal dose of rotenone has reached the end of the treatment segment. Caged fish placed below the detoxification station will be monitored for the presence of rotenone in the water. Because fish are some of the most sensitive species to rotenone, the presence of the chemical in the water can be determined by observing the behavior and survival of caged fish. Signs of rotenone poisoning include loss of equilibrium and death. If

signs of rotenone poisoning occur below the primary detoxification station $KMnO_4$ will be administered to the water at the secondary detoxification station.

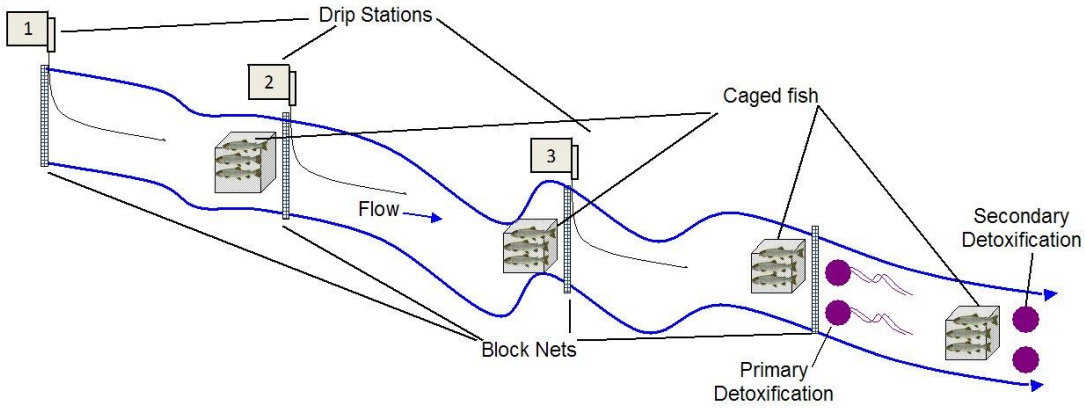


Figure 6. Schematic of a typical chemical treatment and bioassay consisting of drip stations block nets caged target species and detoxification stations.

At least two rotenone treatments (in consecutive years) will be conducted to ensure complete removal of nonnative fish. Rotenone treatments will continue until no nonnative fish are found during the chemical treatment. The actual rotenone treatments and detoxification will last between four and eight days depending on the scope of the treatment. All equipment will be removed from the treatment area immediately following the day of the treatment.

Most fish killed during the chemical treatment will be allowed to decompose naturally within the stream. The dead fish will be widely distributed within the treatment reach and will not serve as a concentrated food source for grizzly bears. Fish will decompose within the stream within one week.

## *Restoration Process Timeline*

The Wyoming Game and Fish Department will hold a public meeting from 6-7 p.m. February 8, 2016 at the Park County Library in Cody (1500 Heart Mountain St.) to discuss the proposed treatment of Eagle Creek to restore native Yellowstone cutthroat trout. Public comments on the proposed treatment will be accepted until 5 p.m. February 29, 2016 through an on-line portal (https://wgfd.wyo.gov/).

The first application of rotenone to remove nonnative Brook trout could occur as early as the summer of 2016 and will be repeated at least one additional year to ensure complete removal. Following the complete removal of Brook Trout, Yellowstone Cutthroat Trout will be stocked into the treatment area to establish a population. Stocking and population monitoring will occur for multiple years to ensure the establishment of a Yellowstone Cutthroat Trout population.

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